how information flows, how it is corrupted and manipulated, and how it is ultimately received is summarized by interconnecting block diagrams: The outputs of one or more systems serve as the inputs to others.

In the communications model, the **source** produces a signal that will be absorbed by the **sink**. Examples of time-domain signals produced by a source are music, speech, and characters typed on a keyboard. Signals can also be functions of two variables an image is a signal that depends on two spatial variables or more television pictures (video signals) are functions of two spatial variables and time. Thus, information sources produce signals. **In physical systems, each signal corresponds to an electrical voltage or current**. To be able to design systems, we must understand electrical science and technology. However, we first need to understand the big picture to appreciate the context in which the electrical engineer works.

In communication systems, messages signals produced by **sources**must be recast for **transmission**. The block diagram has the message s (t) passing through a block labeled transmitter that produces the signal x (t). In the case of a radio transmitter, it accepts an input audio signal and produces a signal that physically is an electromagnetic wave radiated by an antenna and propagating as Maxwell's equations predict. In the case of a computer network, typed characters are encapsulated in packets, attached with a destination address, and launched into the Internet. From the communication systems "big picture" perspective, the **same** block diagram applies although the systems can be very different. In any case, the transmitter should not operate in such a way that the message s (t) cannot be recovered from x (t). In the mathematical sense, the inverse system must exist, else the communication system cannot be considered reliable. (It is ridiculous to transmit a signal in such a way that no one can recover the original. However, clever systems exist that transmit signals so that only the "in crowd" can recover them. Such crytographic systems underlie secret communications.)

Transmitted signals next pass through the next stage, the evil **channel**. Nothing good happens to a signal in a channel: It can become corrupted by noise, distorted, and attenuated among many possibilities. The channel cannot be escaped (the real world is cruel), and transmitter design **and** receiver design focus on how best to jointly fend of the channel's effects on signals. The channel is another system in our block diagram, and produces r (t), the signal **received** by the receiver. If the channel were benign (good luck finding such a channel in the real world), the receiver would serve as the inverse system to the transmitter, and yield the message with no distortion. However, because of the channel, the receiver must do its best to produce a received message sˆ(t) that resembles s (t) as much as possible. Shannon8 showed in his 1948 paper that reliable for the moment, take this word to mean error-free digital communication was possible over arbitrarily noisy channels. It is this result that modern communications systems exploit, and why many communications systems are going "digital." The module on Information Communication (Section 6.1) details Shannon's theory of information, and there we learn of Shannon's result and how to use it.

Finally, the received message is passed to the information **sink** that somehow makes use of the message. In the communications model, the source is a system having no input but producing an output; a sink has an input and no output.